Warwick Research Unit for the Blind
Summary of Activities 1971-77

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Summary

This brochure presents a short review of the work of the Warwick Research Unit for the Blind. It has been produced in response to frequent requests for information by individuals and organisations with general or specific needs.

Further details on most of the projects have been published, and section 16 gives a list of the principal articles etc. Enquiries regarding the availability of reprints of these should be addressed to the Unit.

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1. Introduction

Research on aids for the blind and visually impaired started in the Department of Engineering at Warwick University in May 1971. Since then the research has expanded bringing in scientists from a range of disciplines. Close contact has been maintained with the organisations of and for the blind both in Britain and in the rest of the world.

The emphasis has been on research on methods of increasing access to information, and the transference of this research to the potential blind user. This has involved the Unit in developing and maintaining close contact with the manufacturers of aids and in related evaluation programmes.

2. Orientation Maps

A blind person who has to find his way round a strange town is faced with two major problems: firstly, the problem of walking along pavements and crossing roads without getting seriously injured, and secondly the problem that the blind person has no knowledge of the layout, or names, of the streets. If a blind persom has some form of mental picture of the street layout he can then add pieces of information to this basic picture. The problem becomes more serious with children who are born blind since they often have great difficulty in understanding the layout of roads and road junctions; for instance the author found that a considerable number of blind teenagers did not realise the purpose or shape of a roundabout. An embossed map can sometimes be useful in these situations.

In making an embossed map the first problem is to choose suitable landmarks for a blind pedestrian. This is not trivial since a guidedog is trained to avoid obstacles such as pillar boxes. Noises and even smells can sometimes be useful in determining one's position.

The information to be included on the map, has to be embossed in a way that is both clear and unambiguous. The sense of touch lacks the fine resolution of vision, so much less can be marked on an embossed map than on a visual one. Contrary to popular belief, blind people do not have a better sense of touch than their sighted peers. The blind often have difficulty understanding many common visual symbols such as the compass rose.

Most blind people have never used an embossed map. Someone who was born blind has to be taught how a map can be a scaled and coded representation of the envrionment. It is also necessary to teach a blind child to scan a map in a systematic manner in order to build up some form of mental picture of the area. This is similar to the problem of a sighted person reading a large wall map but only being allowed to look at one square inch at a time.

To make a clear map by any manual method is very time-consuming and therefore expensive if one takes into account the cost of labour. With these methods it is very difficult to change the scale of the map or to update the information.

A computer-assisted system was developed to overcome these problems. A large scale map is marked up with the extra information which will be useful to a blind pedestrian. This information may include gradients, bus stops, names of shops and likely destinations.

The operator goes selectively round this map with a stylus which is connected to the computer (Figure 1). The map is simultaneously displayed on the screen of the visual display unit. The operator can now modify the map by inserting or deleting individual lines, moving end points of lines and changing the scale.

The ability to change the scale is important since a map is usually an aid to the organisation of information as well as a scaled-down form of representation. It is

Figure 1 Co-ordinate table and visual display unit.

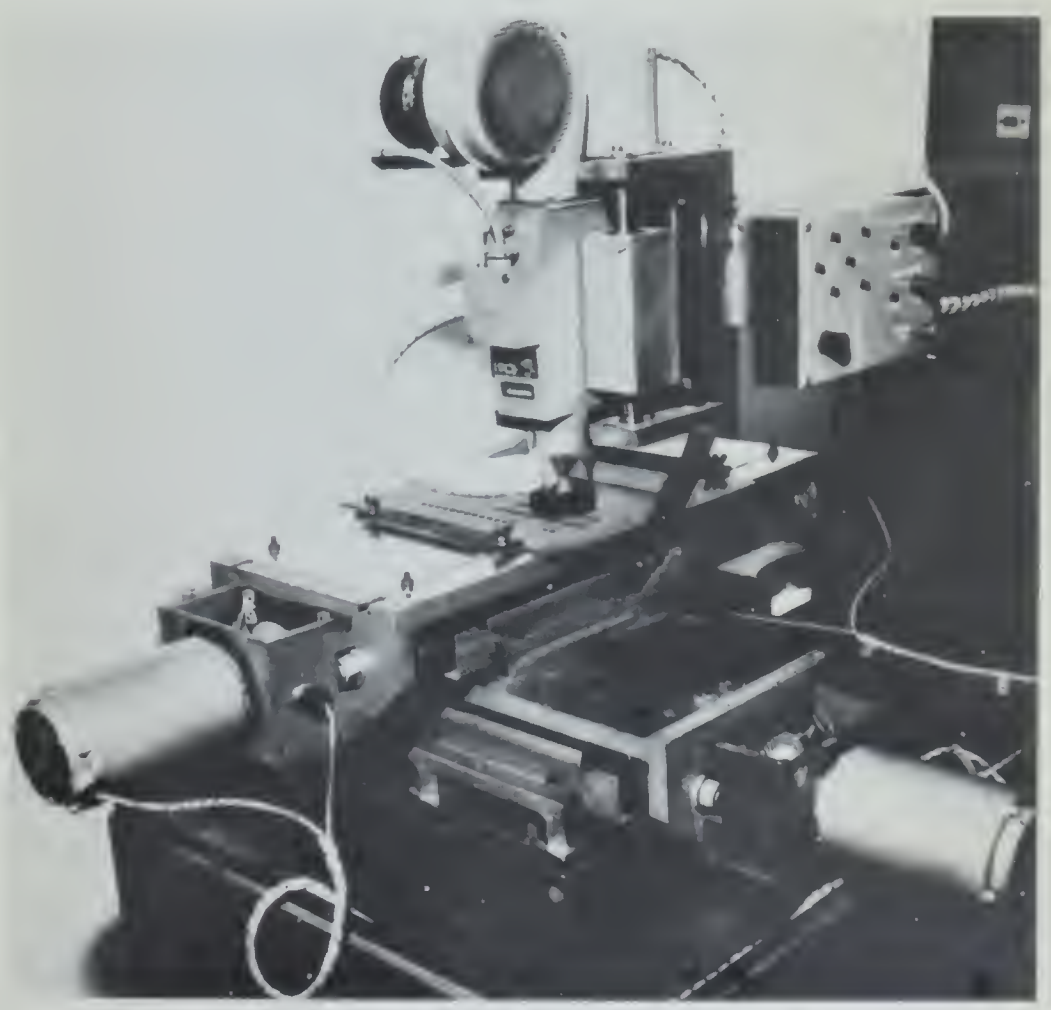

Figure 2 Engraving machine.

often desirable to enlarge an area around a road junction; the blind often measure distance by the time it takes to walk, so a moderate enlargement of a road junction does not create any serious difficulties in interpretation.

The operator can also make the lines have different elevations as well as different forms such as solid, dotted or dashed. Standard symbols, representing features such as zebra crossings or steps, can be added to the display. The operator can also type in text from the keyboard and the computer program will convert it to braille.

When the operator is satisfied with the display, the computer is instructed to punch the numerical data on paper tape. A map can be stored in numerical form on paper tape and then quickly modified at a later date.

The punched paper tape controls an engraving machine (Figure 2) which cuts a mirror-imaged copy of the map. Since the map is engraved into the material, a copy has to be made in epoxy resin. This epoxy copy is identical to the desired shape for the final copies so it is used as a mold in a vacuum-forming machine.

This system offers an inexpensive and faster alternative to the current time-consuming methods for making embossed maps for the blind. The system has now reached the stage where it can be used for routine map production.

The evaluation of these maps has been done by Warwick Research Unit for the Blind in cooperation with the Blind Mobility Research Unit. The initial task was to identify sets of embossed symbols which can be easily distinguished by touch. Eight areal, seventeen line and thirty point symbols were tested; these experiments involved two hundred and fifty-six subjects including blind school children as well as adults who read braille and adults who do not read braille.

The next experiment involved teaching blind school children the meanings of fourteen embossed symbols (Figures 3 and 4). This was done by presenting the child with each symbol in turn, with a tape recording giving the meaning ten seconds later. The child had to beat the tape recording in giving the correct meaning. This test was repeated three weeks later to see how well the children had remembered the symbols and their meanings. The most surprising result was that the children found the symbols for steps going up and steps going down the easiest to remember even though these two symbols only varied in elevation.

After a further three weeks, the children were given an embossed map and asked to find the symbols on the map. In order to determine whether the errors were due to failure to remember the symbols or inability to find them on the map, half the subjects were given a list of symbols with their meanings in braille. There was no significant difference in the number of errors made by these two groups which indicates that tactual scanning is a major problem in learning to read an embossed map.

A further experiment studied the use of single and double line representation of roads. It was found that the subjects, blind adults, were significantly faster at reading the single line map. However it should be noted that the results might have been very different if the subjects had been congenitally blind children.

Maps of the insides of buildings, shopping centres and neighbourhoods have been tested less formally using adult blind subjects. These evaluations have proved useful in ensuring that the research is directed towards realistic situations.

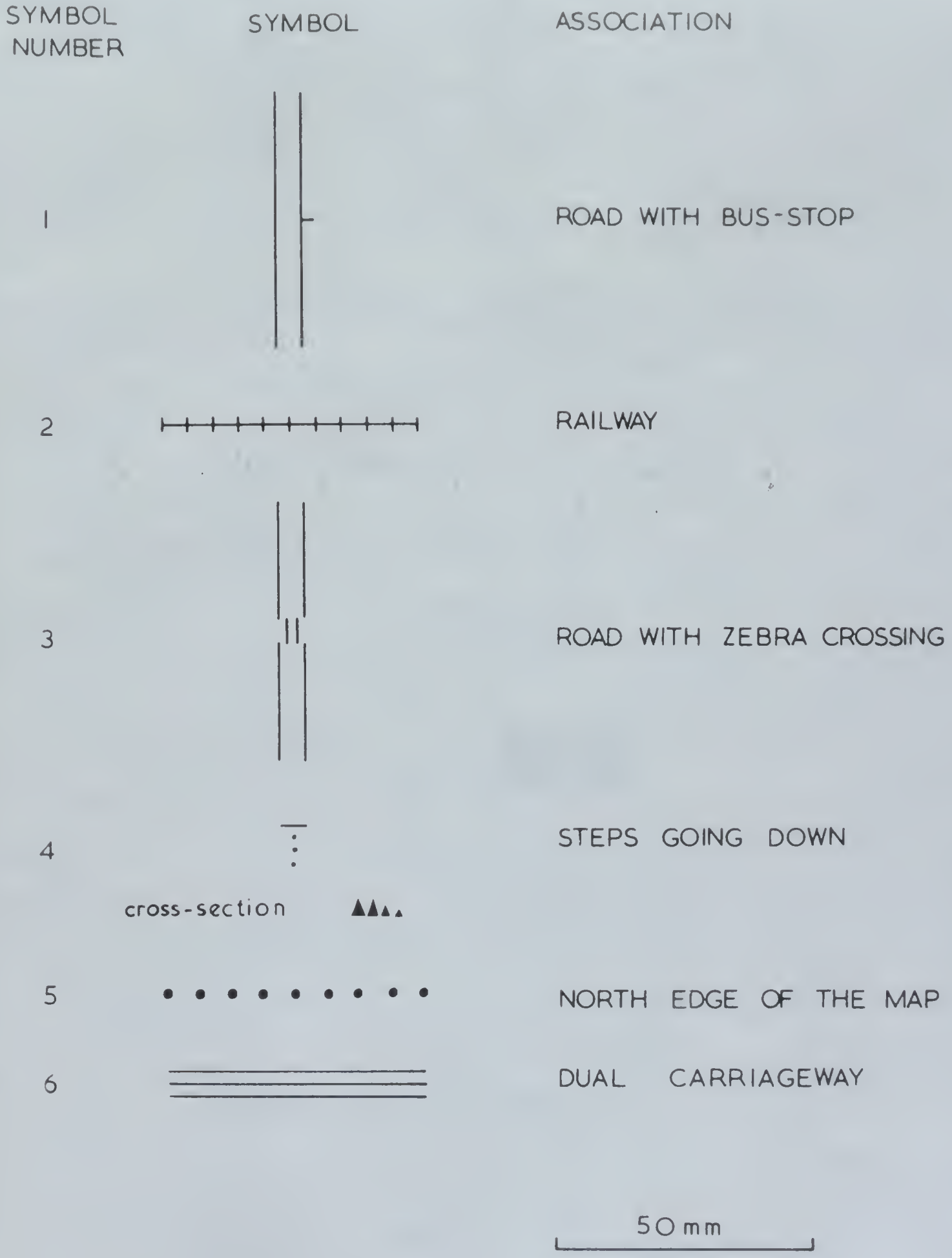

FIG. 3. Print outlines of the tactual symbols presented to the subjects.

SYMBOL NUMBER	SYMBOL	ASSOCIATION
7	- - - - - - - - - - -	FOOTPATH
8	†	CHURCH
9	⊤	STEPS GOING UP
	cross-section ▲▲▲▲	
10		ROAD GOING UPHILL
11		BUILDING WITH ENTRANCE
12		CROSSROADS WITH ROUNDABOUT
13		CROSSROADS WITH TRAFFIC LIGHTS
14	T	TOILET

50 mm

FIG. 4. Print outlines of the tactual symbols presented to the subjects.

3. Transcription of Short Documents

Braille readers often have problems in having short documents transcribed quickly into contracted braille. Typical documents are agendas and minutes of meetings, instructions for domestic appliances, local telephone dialling codes, knitting patterns and personal correspondence needed for reference. Typically the number of copies required is from one to six. This project is concerned with investigating the viability of using a computer-based transcription system based on existing technology to provide this personal service.

The basic system for producing short documents in contracted braille is:

(i) A typist, with no computing knowledge, inputs the text on punched cards, paper tape or directly on a visual display unit. Control characters, for new paragraph etc., are also added by the typist as she inputs the material (i.e. the text is not annotated by someone else).

(ii) A line printer listing of the text is produced in order to proof-read for typing errors.

(iii) The text is interactively edited on a visual display unit with a program designed specifically for this purpose. This program has been designed for speed of operation, minimal computing requirement and for ease of use by operators with no experience of computing.

(iv) The text is translated to a good approximation to Grade II standard English Braille.

(v) The braille is output on an on-line embosser.

Only the translation phase requires extensive central processor time; all other computer operations use less than 1% of the central processor time, and can be time shared with other unrelated programs.

An important feature of the project is the assessment of demand, cost, and achievable service in terms of acceptability of the quality of the computer produced braille and turn round time. So far over a million words have been transcribed as part of the evaluation programme.

The material transcribed can be roughly grouped as:

Subject	%
Domestic	10.4
Leisure	15.4
Religious	2.5
Education	25.4
Employment	29.1
Miscellaneous	17.2

A questionnaire was circulated to the blind subjects who had used the system. The results show that both the number of miscontractions and the use of single-sided braille are acceptable for this application. This project has demonstrated that there is a considerable demand for short documents in braille, and that computer-based systems can potentially satisfy a significant proportion of this demand.

The traditional braille cookery book is made of manilla paper bound in a large volume. This means that the blind housewife has to allocate sufficient working space for the cookery book, and has to wash and dry her hands each time she wishes to refer to the recipe. The system tested at Warwick involved reproducing the recipes in plastic sheet and bound loose-leaf in a ring binder (Figure 5). The recipes can be removed from the folder and sponged down after cooking. The reaction of the users has been uniformly favourable so the details of the system have been passed

Figure 5 A washable braille cookery book

on to the established service organisations.

Reading stimulation often comes from family and friends being able to join in. Braille looks completely alien to parents (who are often non-braillists), siblings and fiends. Some books were produced in both braille and print - each braille page having a corresponding large print page bound opposite, so that anyone can participate.

These books include short stories, interlined stories for the very young and a puzzle book incorporating a tactile maze. Encouraging comments have come back from the children, expressing enjoyment in being able to involve their family and friends and asking for "more please".

4. Braille Bank Statements

Lack of privacy is one of the most serious deprivations caused by blindness, therefore the availability of bank statements in braille can be very important to some blind individuals. Manual production requires highly skilled braille transcribers who are in short supply, also manual transcription usually introduces a considerable time delay. In order to be useful bank statements must be up-to-date, and no errors can be tolerated. These conditions are met by the automatic transcription of statements from digital data provided by the banks. Lloyds, Lewis's and Midland banks use this system on a regular basis to provide braille statements to their blind customers.

The banks supply the data recorded digitally in print-image format on 9-track magnetic tape but the names and addresses of the customers are not included. The program to convert the print-image format to the braille format is written in Fortran IV for the Sigma 5 computer. As well as changing the format, the program checks that the input data is in the correct fields and that the final balance is correct. If there were an error, the braille statement would be suppressed and an error message would be output

on the line printer. The program also produces a sighted printout in the same format as the braille version in order to assist the customer's branch in dealing with any queries which the blind customer may raise.

Another advantage of this automated system is speed; it takes only a matter of minutes to produce a batch of statements from the digital tape. Demand for this service is currently in excess of 5000 braille pages per year.

5. Selective Dissemination of Information

For any blind person with a scientific or technical background, keeping up-to-date with his subject raises special problems. The sighted person can go to his library and browse at will; and it is an accepted part of the work environment that resources are made available for him to do so. The blind person must obtain the help of his sighted friends and colleagues to read relevant articles for him; but before he can even do this, he needs a means of identifying what is relevant to him from current scientific literature. In the absence of any braille alerting service, he must depend upon having access to a sighted colleague with an equivalent technical background and a proper understanding of his interests.

This is a very real problem in the field of computer science, where technological change is rapid and continuous. In other respects, computing has been able to offer particularly good opportunities for the employment of blind staff on equal terms with their sighted colleagues. To give some idea of the size of the problem INSPEC, the information service run by the Institution of Electrical Engineers, adds about 130,000 items per year to its data base which covers physics, electro-technology, computers and control. To handle this volume of information the system is, of necessity, computer-based. The routine INSPEC service provides each subscriber with a list of articles within

the user's personal fields of interest. With our pilot scheme, each month INSPEC supplies the Unit with a computer-readable tape containing abstracts of recently published articles from computer science journals. A computer program automatically selects the abstracts of specific interest to each blind programmer associated with the project. The text is then automatically translated to contracted braille which is embossed directly on manilla paper. The braille is ring-bound, with stiff covers to protect the embossing, before being dispatched to the blind users.

In cooperation with the American Psychological Association a service similar to that described previously is provided for alerting a group of blind psychologists to articles of specific interest to them.

6. Compositors' Tapes

In the printing industry compositors tapes have been in use for many years. However the traditional system involves correcting the errors on the type itself and not on the compositors tape. There are also a multiplicity of codes in use which make it difficult to write a computer program to read a range of these tapes.

However error-free computer-compatible tapes are now becoming available with the introduction, by printers, of computer-based composing systems. These tapes offer an inexpensive fast method for producing braille books which only include ordinary text (i.e. no mathematics, music, tables or diagrams).

The Unit is working in collaboration with Cambridge University Press who generate tapes which are error-free and contain many control characters desirable for the automated production of the braille edition. A sample section of a book has been successfully produced in braille.

7. Braille Input to a Computer

At the present time there is no satisfactory system for transcribing manually or automatically specialist braille codes such as mathematics, which is compatible with the computer-assisted systems for literary text. Such a system may be highly desirable, as for example many books contain a large proportion of ordinary text and a small amount of mathematics or scientific notation.

A braille keyboard has been interfaced to a computer, and software has been written to input from this keyboard, display and interactively edit on a graphics terminal. The data is then merged with ordinary text before it is processed by the translation program. This means that the mathematics appears in the correct position in the braille output.

8. Storage of Braille on Cassette

An associated development has been the interfacing of a Perkins braillewriter with a domestic cassette tape deck. A skilled transcriber can input on the conventional braille keyboard, obtain an immediate copy on manilla paper as well as storing the data on cassette. The cassette can later be read into a small computer for interactive editing and production of multiple copies on manilla paper.

This type of system could help manual transcribers in producing multiple copies of braille texts on manilla paper. A further development could be the incorporation of a microprocessor to permit local interactive editing.

9. Braille Music

A computer program is being developed to translate standard music notation into the braille code. The program permits an operator, without any knowledge of computers or the braille code, to input music from a standard

keyboard. The music is displayed in the standard music notation on a graphics terminal for checking against the original score, and the operator can interactively edit the data. The data is translated and output on the on-line embosser without human intervention. The system has been used to produce a sample of part of a piano sonata and, on the basis of feedback from blind musicians, the system is being improved.

10. Braille Automation Newsletter

In collaboration with the American Foundation for the Blind, the Braille Automation Newsletter has been produced as an aid in communicating among that community of researchers and developers interested in applied research involving braille production with computer-assisted systems. The Newsletter is produced three times a year and is distributed internationally.

11. Devices

The Unit has been involved in designing a large number of devices to help the blind and visually impaired. There is only room here to give two examples.

An electric digital clock with audio output has been developed for the elderly and diabetic blind. This device is now being manufactured by an H.M. Prison.

Another development is a remote position indicator. For instance a blind person may leave the device by his lawnmower when he is emptying the grassbox. On return he claps his hands, within 30 feet of the mower, and the device will give out a short 'beep'. This device will probably be manufactured by a workshop for the physically handicapped.

12. Non-Visual Displays

Many aids for the sensory impaired involve communicating information from a machine to a human by a sense other than the usual one. If the visual channel cannot be used it becomes essential to make optimal use of other communication channels. However very little is known about the optimal design of single or multi-modal displays for the man-machine interface.

The first series of experiments involved a compensatory tracking task with random input signals (five different cut-off frequencies) with five one-dimensional displays where the error is represented by:

(i) Visual: deflection

(ii) Auditory: mark-space ratio

(iii) Auditory: matching frequency

(iv) Auditory: beat frequency

(v) Auditory: amplitude matching

The analysis of results included a comparison of the measured closed-loop frequency response with that obtained from a modified form of cross-over model. From these results it was possible to define two performance parameters for assessing displays.

The second series of experiments involved a comparison between various audio error displays and a visual display in terms of monitoring the change in the operator's response to a step change in the frequency bandwidth of the input signal. The operator describing function was modelled using a modified 5-parameter cross-over model, and the applicability of this model during periods of transient response was verified.

13. Research Information

In collaboration with the American Foundation for the Blind, a register of research has been compiled. This register contains a list of all known non-medical research projects for the blind and visually impaired.

A new edition is being compiled which will also contain a list of the main organisations of and for the blind throughout the world, and a list of sources of information about the blind and visually impaired. The register is being produced in inkprint, grade 1 and grade 2 braille.

The previous editions of this register have been received enthusiastically by research workers all over the world.

14. Foreign Contacts

The Unit has been visited by research workers from many countries. Members of the Unit have also been given the opportunity to visit scientists in France, Switzerland, Austria, Denmark, Netherlands, German Federal Republic, German Democratic Republic, Czechoslovakia, Poland, Soviet Union, Hungary, Yugoslavia, Bulgaria, USA, Canada and Brazil.

15. Funding

The financial assistance of the following organisations is gratefully acknowledged:

American Foundation for the Blind
Bank of England
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Ford of Britain Trust

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Medical Research Council
Midland Bank Ltd.
National Computing Centre
National Westminster Bank Ltd.
Ocean Transport and Trading Ltd.
Royal National Institute for the Blind
Science Research Council
William and Glyn's Bank Ltd.

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